



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification 5 :</b>  <b>H04Q 7/04</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 92/13428</b>  <b>(43) International Publication Date:</b> 6 August 1992 (06.08.92)
<b>(21) International Application Number:</b> PCT/FI91/00403 <b>(22) International Filing Date:</b> 19 December 1991 (19.12.91)  <b>(30) Priority data:</b> 910211 15 January 1991 (15.01.91) FI  <b>(71) Applicant (for all designated States except US):</b> TELENOKIA OY [FI/FI]; Mäkkylän puistotie 1, SF-02600 Espoo (FI).  <b>(72) Inventor; and</b> <b>(75) Inventor/Applicant (for US only) :</b> HUOTARI, Seppo [FI/FI]; Harakankuja 6 E 33, SF-02600 Espoo (FI).  <b>(74) Agent:</b> OY KOLSTER AB; Stora Robertsgatan 23, P.O. Box 148, SF-00121 Helsinki (FI).		<b>(81) Designated States:</b> AT (European patent), AU, BE (European patent), CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB, GB (European patent), GR (European patent), IT (European patent), LU (European patent), MC (European patent), NL (European patent), NO, SE (European patent), US.  <b>Published</b> <i>With international search report.</i>
<b>(54) Title:</b> A METHOD FOR SETTING UP AN INCOMING CALL TO A MOBILE RADIO IN A CELLULAR MOBILE RADIO NETWORK		
<div data-bbox="227 1165 357 1197" data-label="Section-Header"> <b>(57) Abstract</b> </div> <div data-bbox="227 1207 755 1690" data-label="Text"> <p>The invention relates to a method for setting up an incoming call to a mobile radio in a cellular mobile radio network. In the method, one of the switching centres (MSC1, MSC2, GMSC) receives the subscriber number of the mobile radio (MS) and requests the home location register (HLR) to provide call routing information. The home location register (HLR) requests the routing information from the visitor location register (VLR1, VLR2) within the location area of which the mobile radio is currently located, and forwards the received routing information to the requesting switching centre for routing the call to the switching centre of the current service area and further to the mobile radio. The mobile radio is searched by a paging initiated immediately by the switching centre within the location area when the associated visitor location register receives the routing information request.</p> </div> <div data-bbox="771 1144 1461 1869" data-label="Diagram"> <pre> graph TD     PSTN_PSPDN_ISDN[PSTN PSPDN ISDN ...] --&gt; GMSC     GMSC &lt;--&gt; HLR     HLR --&gt; VMSC1     HLR --&gt; VMSC2     subgraph VMSC1 [VMSC1]         MSC1 &lt;--&gt; VLR1     end     subgraph VMSC2 [VMSC2]         MSC2 &lt;--&gt; VLR2     end     MSC1 --&gt; BSC1     MSC2 --&gt; BSC2     BSC1 --&gt; BTS1     BSC1 --&gt; BTS2     BSC2 --&gt; BTS3     BSC2 --&gt; BTS4     BTS1 -.-&gt; MS1[MS]     BTS2 -.-&gt; MS1     BTS3 -.-&gt; MS2[MS]     BTS4 -.-&gt; MS2   </pre> </div>		

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A method for setting up an incoming call to a mobile radio in a cellular mobile radio network

The invention relates to a method for setting  
5 up an incoming call to a mobile radio in a cellular  
mobile radio network comprising a home location  
register for permanently storing location and sub-  
scriber data concerning mobile radios registered with  
the network, the geographical coverage area of the  
10 network being divided into smaller service areas each  
comprising a visitor location register for temporar-  
ily storing subscriber data concerning mobile radios  
currently located within said service areas, and a  
switching centre associated with the visitor location  
15 register, the geographical coverage area of each  
service area being further divided into location  
areas each further divided into radio cells each com-  
prising at least one fixed radio station capable of  
establishing a radio link with the active mobile  
20 radios currently located in the radio cell.

In various cellular radio or mobile radio  
systems presently in use or being developed the  
geographical coverage area of the system is divided  
into smaller separate radio areas or cells in such a  
25 way that when the mobile radio is in a cell, it com-  
municates with a fixed network through a fixed radio  
station located in the cell. Mobile radios belonging  
to the system are free to roam from one cell to an-  
other within the area of the system. An example of  
30 such systems is the digital mobile radio system GSM  
(Groupe Spécial Mobile). When a subscriber in the  
same system or in an external system wants to call a  
mobile radio or a mobile subscriber MS in this kind  
of cellular system, the fixed network has to know the  
35 actual location of the mobile radio MS in order to be

able to route the call to the right mobile services switching centre MSC. In the GSM system, for example, the number selected by a calling subscriber contains no information on the actual location of the called MS. Therefore, to set up the connection, it is necessary to determine the location of the MS by utilizing a routing address, i.e. the mobile radio roaming number. In the GSM system, this information can be provided solely by the home location register HLR, which is a database in which subscriber data, such as location data, are stored permanently. Therefore, in order to be able to route the call to the MSC within the area of which the MS is currently located, it is necessary to send a request to the HLR.

In the GSM system, each location area consisting of several radio cells comprises a visitor location register VLR, which is a database in which subscriber data are stored while the subscriber visits the area of the VLR. The VLR gives the HLR the information required for routing calls to the MS and participates e.g. in the switching of calls in the MSC.

There are two alternative ways of giving the routing information, i.e. a roaming number. First, the roaming number can be given when the VLR updates the location of the subscriber, and the roaming number is stored in the HLR. In this case, the HLR returns the stored roaming number without further procedures when it receives a routing information request.

Secondly, the HLR may request the VLR within the area of which the MS is currently located to provide a roaming number assigned exclusively to this call when requested by a gateway MSC or one of the

MSCs. The HLR forwards the roaming number provided by the VLR to the requesting MSC, and so the MSC routes the call to the right MSC on the basis of the roaming number. After the call has been routed up to the MSC, the MSC initiates a mobile radio paging procedure within its location area to find the cell and the fixed radio station within the area of which the MS is located. After finding the MS, the MSC establishes a radio link with the MS through this fixed radio station and sets up the call.

The object of the invention is to speed up the call setup procedure in this type of cellular mobile radio system.

This is achieved by a method according to the invention, wherein, when the visitor location register receives the routing information request from the home location register, the switching centre associated with the visitor location register initiates immediately the paging of the mobile radio within the location area.

As already mentioned above, the HLR requests the current VLR to provide a roaming number in systems where the roaming number is assigned separately for each call. In the invention this is utilized in such a manner that the MSC associated with the VLR initiates the paging of the mobile radio within its area, and performs authentication, ciphering, and other required procedures immediately after the reception of the request instead of performing them only after the call has actually been routed to the MSC in question. This speeds up the setup procedure for the incoming call, that is, shortens the waiting time for the calling subscriber. The invention is particularly advantageous in cases where the MSC and the VLR are integrated, whereby the interface

between them can be easily realized otherwise than as specified in the GSM recommendations without causing any compatibility problems or other difficulties on the system level.

5           In one embodiment of the invention, the VLR sends a roaming number to the HLR immediately after receiving a request if the data contained in the VLR indicates that the mobile radio in question is active. In another embodiment of the invention, the  
10       VLR transmits a roaming number to the HLR only after successful completion of the mobile radio paging procedure. If the paging procedure fails, the VLR informs the HLR about the failure, and the call is released. This procedure avoids unnecessary assignment  
15       of speech channels in the network.

The invention will now be described in greater detail by means of illustrating embodiments with reference to the attached drawings, in which

20           Figure 1 illustrates schematically a cellular mobile radio system in which the method according to the invention can be applied;

Figure 2 is a signalling diagram illustrating a prior art call setup procedure;

25           Figure 3 is a signalling diagram illustrating a setup procedure for an incoming call in accordance with the invention; and

Figure 4 is a signalling diagram illustrating another setup procedure for an incoming call in accordance with the invention.

30           In the following the method according to the invention will be explained in conjunction with the digital GSM mobile radio system, which, in fact, is the primary field of application of the invention. However, the method according to the invention can  
35       also be applied in other similar mobile radio systems

or in the modifications of the GSM system. The basic structure and basic operations of the GSM mobile radio system are obvious to those skilled in the art and relatively accurately defined in the GSM specifications. In the text below, some of the basic concepts and elements of the GSM system will be defined referring to Figure 1 in so far as they are significant for the understanding of the invention. An area within which the GSM mobile radio services are available is called a GSM network (GSM service area) which may cover several countries. The GSM network may be divided into national GSM networks (PLMN service area), which means the area of one operator providing GSM services. There may also be several GSM networks in one country and their coverage areas may overlap geographically. In the following the mobile radio system refers mainly to a "national" mobile radio network which may communicate with other national mobile radio networks or other telecommunication networks, such as a public telephone network PLMN.

The national GSM network may comprise one or more MSC service areas, that is, one or more areas in which a single MSC provides services. The MSC service area may further be divided into one or more location areas covered by one or several radio cells. The term cell refers to the smallest geographical area of the system comprising one or more fixed radio stations or base stations and utilizing predetermined traffic channels.

The national GSM network usually contains one home location register HLR, which is a database in which mobile radio data, such as location data, are stored permanently. The system further comprises one or more visitor location registers VLR for each MSC service area. The VLR is a database in which mobile

radio data are stored while the mobile radio visits the area of the VLR. The VLR stores information on the location of the mobile radio MS with the accuracy of one location area. The HLR in turn stores information on the VLR which the mobile radio MS visits and provides routing information to the mobile radio network for calls terminating in the mobile radio MS. The HLR in turn obtains the required routing information from the VLR. The HLR and the VLR have solely a signalling connection with the other components of the mobile radio network.

The method according to the invention is primarily intended to be applied in a system shown in Figure 1, in which each MSC service area has its own visitor location register VLR integrated with the MSC of the particular MSC service area. Figure 1 shows two service areas in one of which a mobile services switching centre MSC1 and a visitor location register VLR1 form an integrated unit VMSC1 and in the other of which a mobile services switching centre MSC2 and a visitor location register VLR2 form an integrated unit VMSC2. Under the two service areas covered by the integrated units VMS1 and VMS2, there are one or more location areas, traffic within each location area being controlled by a base station controller BSC controlling several fixed radio stations or base transceiver stations BTS. Each radio cell mentioned above contains one base station BTS, and one base station controller BTS serves several cells. A mobile radio MS located in a cell establishes a two-way radio link with the BTS of this particular cell. There is both a signalling connection and speech channels between the base station controller BSC and the MSC.

In Figure 1, the VMSC1 controls a base station



controller BSC1, which in turn controls base stations BTS1 and BTS2. Within the other service area, the VMSC2 controls a location area comprising a base station controller BSC2 and base stations BTS3 and  
5 BTS4.

In general, the GSM network communicates with other networks, such as a public telephone network (PSTN), another mobile radio network (PSPDN) or an ISDN network, through a certain mobile services  
10 switching centre called a gateway MSC (GMSC). One or some (all) of the MSCs of the network may serve as a gateway MSC. It is possible to establish a speech channel connection from the gateway MSC to any other MSC of the network. The gateway MSC further has a  
15 signalling connection with the home location register HLR. The HLR in turn has a signalling connection with the visitor location registers VLR. Alternatively, the switching centre of another telecommunication system, such as an ISDN centre, may serve as the  
20 gateway MSC.

Figure 2 shows a signalling diagram in which the setup of an incoming call is performed in compliance with the GSM recommendation. The MSC, in this specific case the gateway MSC, receives an international telephone number of a mobile radio MS (international ISDN number) from another network, and forwards it to the home location register of the mobile radio network so as to request it to provide routing information. Alternatively, the HLR may receive the  
25 routing information request from the centre of another telecommunication system, such as an ISDN centre. The HLR checks from its data file the visitor location register VLR within the area of which the mobile radio MS having this particular ISDN number is  
30 currently located and requests this visitor location  
35

register to provide a roaming number by sending it an international mobile station identifier IMSI used within the mobile radio network. In Figure 2, the VMSC (integrated VLR and MSC) assigns a roaming number MSRN for the mobile radio MS for this call and sends it to the HLR. The HLR forwards the roaming number MSRN as routing information to the gateway MSC (or to another switching centre which has requested it), and the gateway MSC routes the incoming call on the basis of this routing information to the MSC of the particular VMSC. The MSC initiates the paging of the mobile radio within that location area of its MSC service area in which the mobile radio should be located by sending the IMSI identifier of the mobile radio. On receiving the paging signal, the mobile radio acknowledges the receipt. The authentication, ciphering, and other possible procedures associated with the B subscriber are then carried out in compliance with the GSM specification, and the call is set up between the A subscriber and the mobile radio MS.

Figure 3 shows a signalling diagram in which the call setup takes place in accordance with the preferred embodiment of the method according to the invention. In Figure 3, similarly as in Figure 2, on receiving the telephone number of the mobile radio the gateway MSC requests the HLR to provide routing information by sending it the ISDN number of the mobile radio, as a result of which the HLR in turn requests the VMSC within the area of which the mobile radio MS is currently located to provide a roaming number by sending the IMSI identifier to it. The VLR in the VMSC assigns the mobile radio MS a roaming number MSRN for this call and sends it to the HLR, which forwards it to the GMSC. The GMSC starts to

route the call to the MSC of the appropriate VMSC on the basis of this routing information.

As distinct from Figure 2, the VLR in the VMSC shown in Figure 3 responds to a roaming number request received from the HLR by causing the MSC in the same VMSC to immediately start the paging of the mobile radio within its area, and after finding the mobile radio, to start the above-mentioned authentication, ciphering and other required procedures. In this way a link required for the call is established between the VMSC and the mobile radio MS, while the gateway MSC routes the call to the VMSC, whereby a speech connection between the subscriber A and the mobile radio representing the subscriber B can be set up immediately after the establishment of the connection between the GMSC and VMSC. This shortens considerably the time the subscriber A has to wait for the call setup.

As explained above, the VLR in the VMSC shown in Figure 3 sends the roaming number to the HLR immediately after receiving the request in so far as the mobile radio in question is active according to the information contained in the VLR (the mobile radio has been switched on). Figure 4 shows a signalling diagram which illustrates an alternative embodiment of the method according to the invention. Similarly as in Figure 3, the VMSC in the method shown in Figure 4 responds to the roaming number request received from the HLR by immediately starting the paging of the mobile radio, the authentication, ciphering, etc. However, the signalling shown in Figure 4 deviates from Figure 3 in that the VMSC does not send the roaming number to the HLR until after the paging procedure has been successfully completed, that is, the mobile radio has sent an acknowledge-

ment. The signalling and call setup then continues as shown in Figure 3. If the paging procedure fails and the mobile radio is not found, the VMSC informs the HLR about the failure and does not send a roaming  
5 number, which results in the release of the call. This is advantageous in that the call is not unnecessarily routed up to the VMSC, thus avoiding unnecessary assignment of the internal connections of the network. The VMSC may inform the HLR on the  
10 failed paging procedure by means of the signal which in the GSM specifications is assigned to forward information when the mobile radio MS is not active.

Since the invention influences only the realization of the VMSC, that is, the integrated VLR and  
15 MSC, all signalling taking place in the network can be performed fully in compliance with the GSM specifications and it needs not to be explained in more detail herein. As to the internal structure of the VMSC, the arrangements required for realizing the  
20 invention are obvious to those skilled in the art on the basis of the above description, and may vary depending on the technology used in each particular case.

Even though the method according to the invention has been described above in conjunction with the  
25 GSM mobile radio system, it is to be understood that it can also be applied in other mobile radio systems of the same type, or in the modifications of the GSM system. The figures and the description related to  
30 them are also otherwise solely intended to illustrate the present invention. In its details, the method according to the invention may vary within the scope of the attached claims.

## Claims:

1. A method for setting up an incoming call to a mobile radio in a cellular mobile radio network comprising a home location register (HLR) for permanently storing location and subscriber data concerning mobile radios (MS) registered with the network, the geographical coverage area of the network being divided into smaller service areas each comprising a visitor location register (VLR1, VLR2) for temporarily storing subscriber data concerning mobile radios (MS) currently located within said service areas, and a switching centre (MSC1, MSC2) associated with the visitor location register, the geographical coverage area of each service area being further divided into location areas each further divided into radio cells each comprising at least one fixed radio station (BTS1-4) capable of establishing a radio link with the active mobile radios (MS) currently located in the radio cell, in which system
- one of the switching centres (MSC1, MSC2, GMSC) or a switching centre of another telecommunications system communicating with the network receives the subscriber number of the mobile radio and requests the home location register (HLR) to provide call routing information, and the home location register (HLR) requests routing information from the visitor location register (VLR1, VLR2) within the location area of which the mobile radio (MS) is currently located, and forwards the received routing information to the switching centre which requested it for routing the call to the switching centre (MSC1, MSC2) of the current service area and further to the desired mobile radio (MS), which is searched by a paging procedure initiated by the switching centre

within its location area, characterized in that when the visitor location register (VLR1, VLR2) receives the routing information request from the home location register (HLR), the switching  
5 centre (MSC1, MSC2) associated with the visitor location register initiates immediately the paging of the mobile radio (MS) within the location area.

2. A method according to claim 1, characterized in that the visitor location register  
10 (VLR1, VLR2) sends the routing information to the home location register (HLR) immediately after having received the request if the mobile radio is active according to the information stored in the visitor location register.

3. A method according to claim 1, characterized in that the visitor location register  
15 (VLR1, VLR2) sends the routing information to the home location register (HLR) when the mobile radio paging procedure initiated by the request from the home location register has been successfully completed.  
20

4. A method according to any of the preceding claims, characterized in that the  
25 establishment of a radio link required for the call between the mobile radio (MS) and the fixed radio station (BTS1-4) of the cell where the mobile radio is located is initiated before the call is routed from the requesting switching centre (MSC1, MSC2, GMSC) to a switching centre (MSC1, MSC2) of the current location area.  
30

5. A method according to any of the preceding claims, characterized in that on requesting routing information from the home location register, the switching centre sends the phone number  
35 of the mobile radio to the home location register.

6. A method according to any of the preceding claims, characterized in that on requesting routing information from the visitor location register, the home location register sends  
5 the visitor location register a mobile radio identification number used within the network.

7. A method according to any of the preceding claims, characterized in that the routing information provided by the visitor location  
10 register is a roaming number.

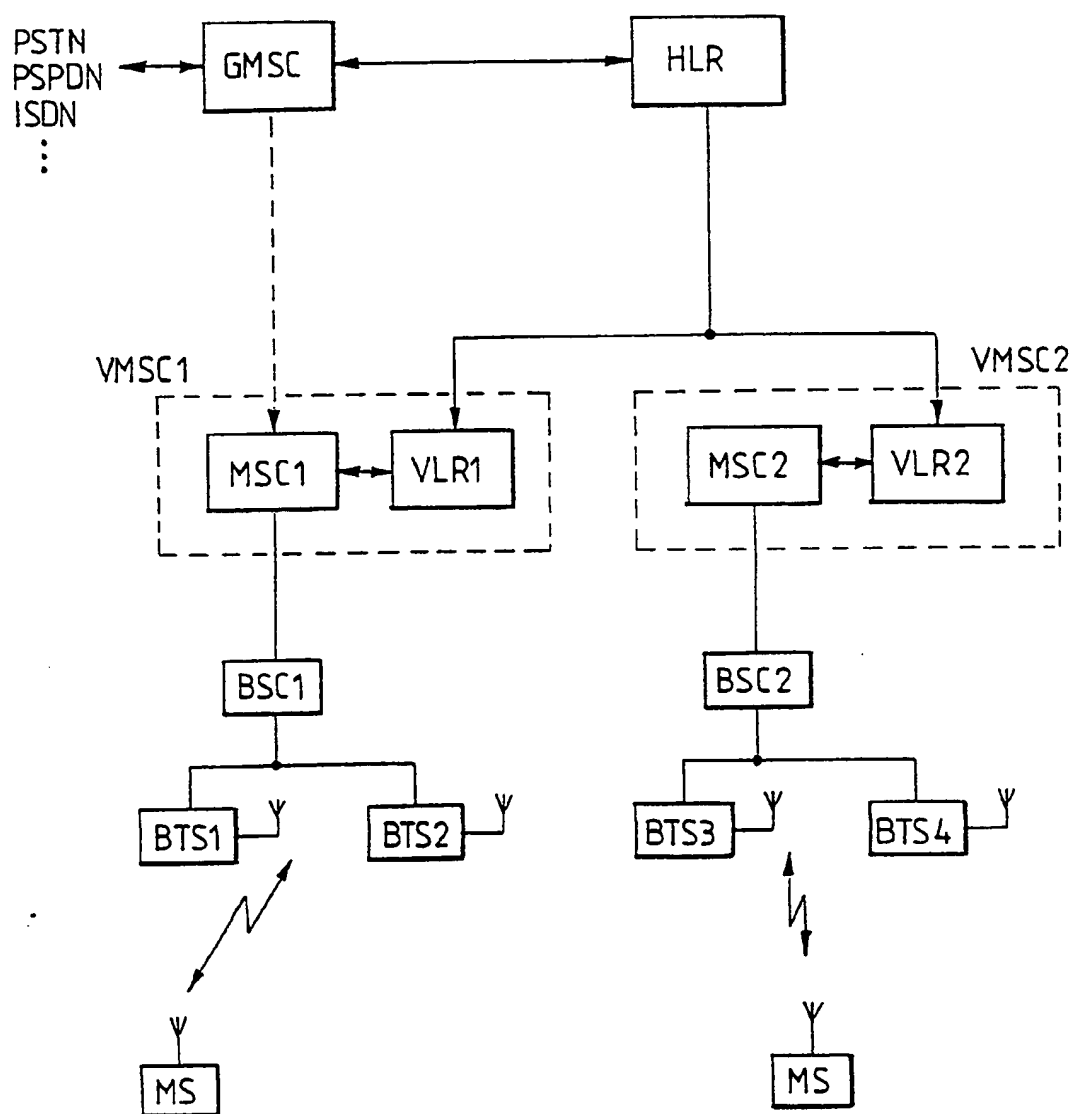
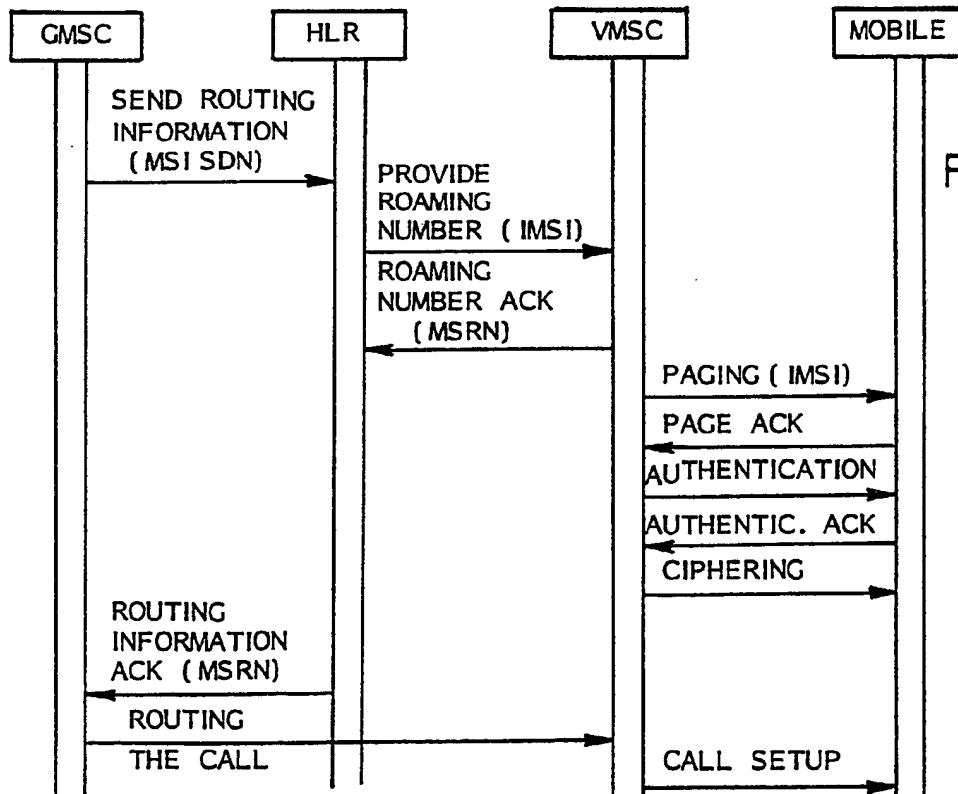
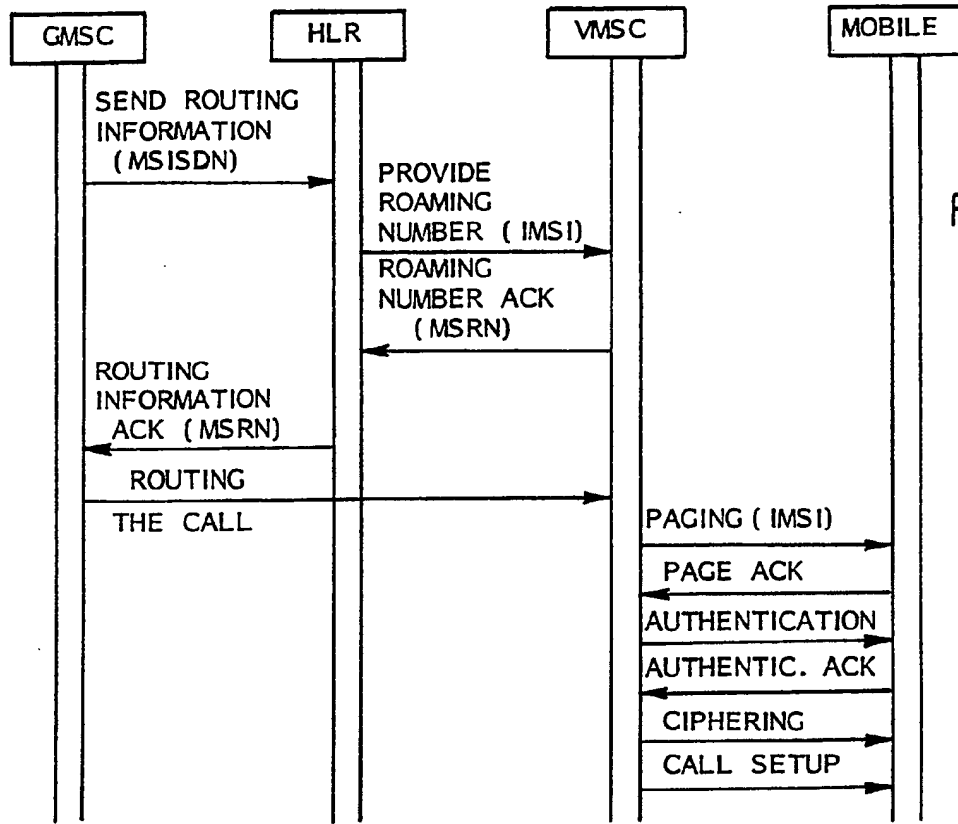


FIG. 1



2/3



3/3

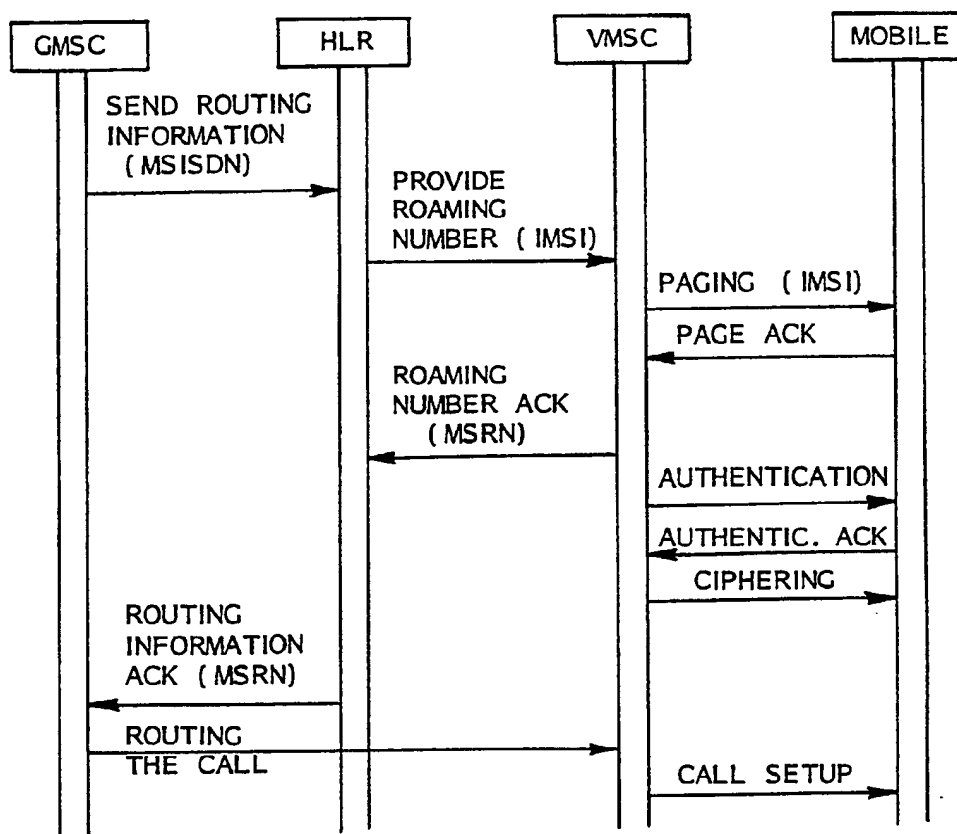


FIG. 4

# INTERNATIONAL SEARCH REPORT

International Application No. PCT/FI 91/00403

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>6</sup> According to International Patent Classification (IPC) or to both National Classification and IPC <b>IPC5: H 04 Q 7/04</b>														
<b>II. FIELDS SEARCHED</b> <div style="text-align: center;">Minimum Documentation Searched<sup>7</sup></div> <table style="width: 100%; border: none;"> <tr> <td style="width: 25%; border: none;">Classification System</td> <td style="border: none;">Classification Symbols</td> </tr> <tr> <td style="border: 1px solid black; padding: 5px;">IPC5</td> <td style="border: 1px solid black; padding: 5px;">H 04 B; H 04 Q</td> </tr> </table>			Classification System	Classification Symbols	IPC5	H 04 B; H 04 Q								
Classification System	Classification Symbols													
IPC5	H 04 B; H 04 Q													
Documentation Searched other than Minimum Documentation to the extent that such Documents are included in Fields Searched <sup>8</sup>  <b>SE,DK,FI,NO classes as above</b>														
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup></b> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;">Category *</th> <th style="width: 60%;">Citation of Document,<sup>11</sup> with indication, where appropriate, of the relevant passages<sup>12</sup></th> <th style="width: 30%;">Relevant to Claim No.<sup>13</sup></th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">A</td> <td>EP, A2, 0167458 (ALCATEL N.V.) 8 January 1986, see abstract --</td> <td style="text-align: center;">1-7</td> </tr> <tr> <td style="text-align: center;">A</td> <td>EP, A2, 0291068 (NEC CORPORATION) 17 November 1988, see abstract --</td> <td style="text-align: center;">1-7</td> </tr> <tr> <td style="text-align: center;">A</td> <td>EP, A1, 0193316 (NEC CORPORATION) 3 September 1986, see the whole document -- -----</td> <td style="text-align: center;">1-7</td> </tr> </tbody> </table>			Category *	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>	A	EP, A2, 0167458 (ALCATEL N.V.) 8 January 1986, see abstract --	1-7	A	EP, A2, 0291068 (NEC CORPORATION) 17 November 1988, see abstract --	1-7	A	EP, A1, 0193316 (NEC CORPORATION) 3 September 1986, see the whole document -- -----	1-7
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A	EP, A1, 0193316 (NEC CORPORATION) 3 September 1986, see the whole document -- -----	1-7												
<div style="display: flex; justify-content: space-between;"> <div style="width: 48%;"> <p><b>* Special categories of cited documents:<sup>10</sup></b></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 48%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"Z" document member of the same patent family</p> </div> </div>														
<b>IV. CERTIFICATION</b> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; border: none;">Date of the Actual Completion of the International Search</td> <td style="width: 50%; border: none;">Date of Mailing of this International Search Report</td> </tr> <tr> <td style="border: 1px solid black; padding: 5px;">23rd April 1992</td> <td style="border: 1px solid black; padding: 5px;">1992 -04- 27</td> </tr> <tr> <td style="border: none;">International Searching Authority</td> <td style="border: none;">Signature of Authorized Officer</td> </tr> <tr> <td style="border: 1px solid black; padding: 5px; text-align: center;">SWEDISH PATENT OFFICE</td> <td style="border: 1px solid black; padding: 5px;"> <i>Lars Heriksson</i>            Lars Heriksson         </td> </tr> </table>			Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	23rd April 1992	1992 -04- 27	International Searching Authority	Signature of Authorized Officer	SWEDISH PATENT OFFICE	<i>Lars Heriksson</i> Lars Heriksson				
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report													
23rd April 1992	1992 -04- 27													
International Searching Authority	Signature of Authorized Officer													
SWEDISH PATENT OFFICE	<i>Lars Heriksson</i> Lars Heriksson													

# ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.PCT/FI 91/00403

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.  
The members are as contained in the Swedish Patent Office EDP file on 28/02/92  
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A2- 0167458	86-01-08	JP-A- 61026338	86-02-05
		US-A- 4700374	87-10-13
EP-A2- 0291068	88-11-17	AU-B- 594298	90-03-01
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